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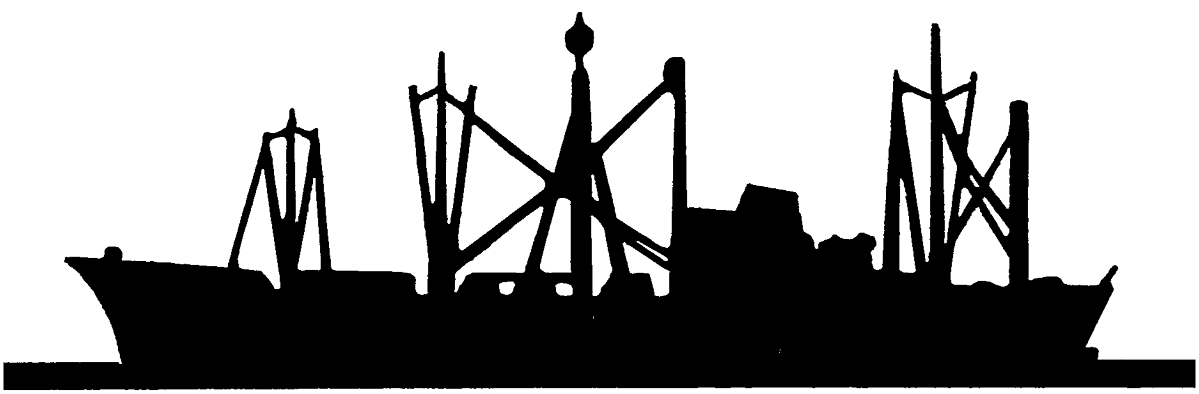

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

COMPUTER ASSISTED PROCESS PLANNING: A FIRST STEP TOWARD INTEGRATION

Alexander HoutzeeL
President
Organization for Industrial Research Inc
Waltham, Massachusetts

ABSTRACT

Computer assisted process planning can be a first step toward the integrated use of computers in the design and manufacturing process to improve productivity in batch manufacturing. The key to the process of integration is a part feature recognition method to analyze and retrieve manufacturing processes and arrive at least-cost designs consistently linked to "best" manufacturing processes. Major problems are incompatible computers, software; and people.

The 1980 recession has served as a sharp reminder of the need for industry to improve its productivity to maximize the results of its investments in people, materials, and equipment.

Inflation and high interest rates have also created intense financial pressures on management.

While these factors have accentuated the need for higher productivity, they are waves on a stream which has been well defined for a number of years. They have been intermingled with other factors, such as shortages in skilled personnel and increased demand for specialized products. Certainly through most of the 70's, management has been driving to get more out of what it has to work with.

A trend in management's favor has been the remarkable advance of computer technology. As everyone knows, computers have been doing a lot more, in much less space, and at much lower costs. There are minicomputers available today which can do the work of the huge mainframe computers of only a few years ago. Computer power which costs hundreds of thousands of dollars or even millions within recent memory, can now be purchased for thousands of dollars.

Software - the systems and programs which put computers to work, has also become increasingly sophisticated. Computers can be programmed to perform many functions which were unheard of a decade ago.

Computers, or minicomputer to be more specific, were relatively slow in making their way on to the shop floor. In the early 60's, numerically controlled equipment promised to revolutionize manufacturing. While N/C certainly has had a significant effect on manufacturing efficiency, it has taken a great deal of time and is slowly approaching the potential its advocates once saw for it. Perhaps because of this experience, or because of the natural conservatism of batch manufacturing management and their cost consciousness, computerization did not gain rapid acceptance.

In very recent years, this has changed somewhat. Computer hardware prices fell to within the budgets 'of small batch manufacturing organizations, and software was designed to meet batch manufacturing needs.

To the buyer, however, contemplating the purchase of a computer system and/or a software system or systems is something like the purchase of stereo equipment. There is a great deal of equipment on the market, much of it differentiated only in subtleties. It is high technology being thrust on an industry which in many ways is relatively low technology - there are bigger and better lathes today, to be sure, but the basic principles of turning have not changed since the industrial revolution.

Even the most sophisticated buyer is confused by the complexities of the hardware and software being offered. The differences between systems are often so thin as to be irrelevant, and in many cases, in the isolated purchase of one system or another, one is "just as good" as the next.

The result has been an electronic Tower of Babel. A computer is purchased here, another computer is purchased there, and programs and software systems are created or purchased to perform specific functions. All is well, as long as the computer is used by a single department for a single function. As companies become more familiar with and comfortable with the computer, however, they rightfully want more for their money.

What they are discovering, is that the piece meal approach to the use of computers has not increased productivity as they envisioned. The computers often do not communicate with each other. They have different kinds of databases,

programming languages, and other aspects which make them difficult if not impossible to integrate.

It is something like trying to increase the flow of a liquid through a pipe. An obvious answer is to make the pipe bigger. A system, such as a computer assisted process planning system or a material requirements planning system or a computer graphics system is purchased to "make the pipe bigger". Unfortunately, it only makes one portion of the pipe bigger and there are still sections which have not been increased. As a result, the amount of liquid coming out the far end is not increased either. All that we have done is make the pipe more expensive.

This is the situation in most of American batch manufacturing today. Many computers, many software systems, but little communication and little long term overall impact.

The answer to this problem lies not so much in the development of new systems but in the implementation of integrated approaches to the use of computers in batch manufacturing.

There are relationships among everything done in design and manufacturing. Computers make it possible to recognize and understand those relationships, and to put them to work to increase productivity.

Computer assisted process planning can help to lower production costs and increase productivity by reducing the amount of time required to prepare process plans and related documentation. At the same time, it is much more useful when it can also be used to take advantage of a company's best manufacturing capabilities and practices, by producing optimal routings - routings which move work across the shop floor in the most efficient and least costly manner. To do so, of course, the computer assisted process planning system requires information about the company's tools, its product mixes, and much else.

Computer graphics is a technology which is just now beginning to be felt in industry. As typewriters have disappeared from newspaper offices, drafting boards will someday be gone from manufacturing design departments. As reporters and editors work with electronic word processing systems, so too will design engineers work with computer graphics systems.

A computer graphics system greatly enhances the capabilities of the design engineer. He or she can solve design problems faster than was once imaginable. If utilized in isolation,

however, this increased speed and power can only lead to more and more design duplication. To be most effective, the computer graphics operator needs to have access to information about parts which have been previously designed (to avoid "reinventing the wheel"). Information about manufacturing processes and their costs is essential if design engineers are to create designs which can be produced most efficiently and at the lowest cost. Obviously, that kind of information relates closely to process planning.

Group Technology is another relatively new force in batch manufacturing. With the right Group Technology system, it is possible to create families of parts, define dedicated machine tools, and do a great deal more to bring mass production economies to batch manufacturing operations.

Again it is obvious, that a great deal of information is required to bring about such results. This information, about machine tools and their capacities and capabilities, least cost processes, product mix, etc. is much the same as the information required to maximize the effectiveness of computer aided process planning and computer graphics.

It is theoretically possible to create separate databases to gather and store the information required for each of these systems. The amount of money and effort required to do so would in many ways negate the advantages. It is much simpler, and much wiser to have a common base of information which these systems and others can use.

The key to such integration lies in the use of a common vocabulary as well as in compatible computer languages.

A universal coding and classification system can provide such a vocabulary. It can be likened to the hub of a propeller. (See Figure 1.) In terms of this discussion, the propeller blades represent computer assisted process planning, computer graphics, and group technology. As the hub of the propeller, the coding and classification system is common to all three and also links them together.

In order to do this, the coding and classification system must have certain characteristics. A simple parts recognition system, for example, would not do the job. Information about the manufactured characteristics of the part is essential, along with other information relating to the kinds of machines required to produce it, materials, tolerances, etc.

At the same time, the systems which are the "blades" of the propeller must have characteristics built into them which

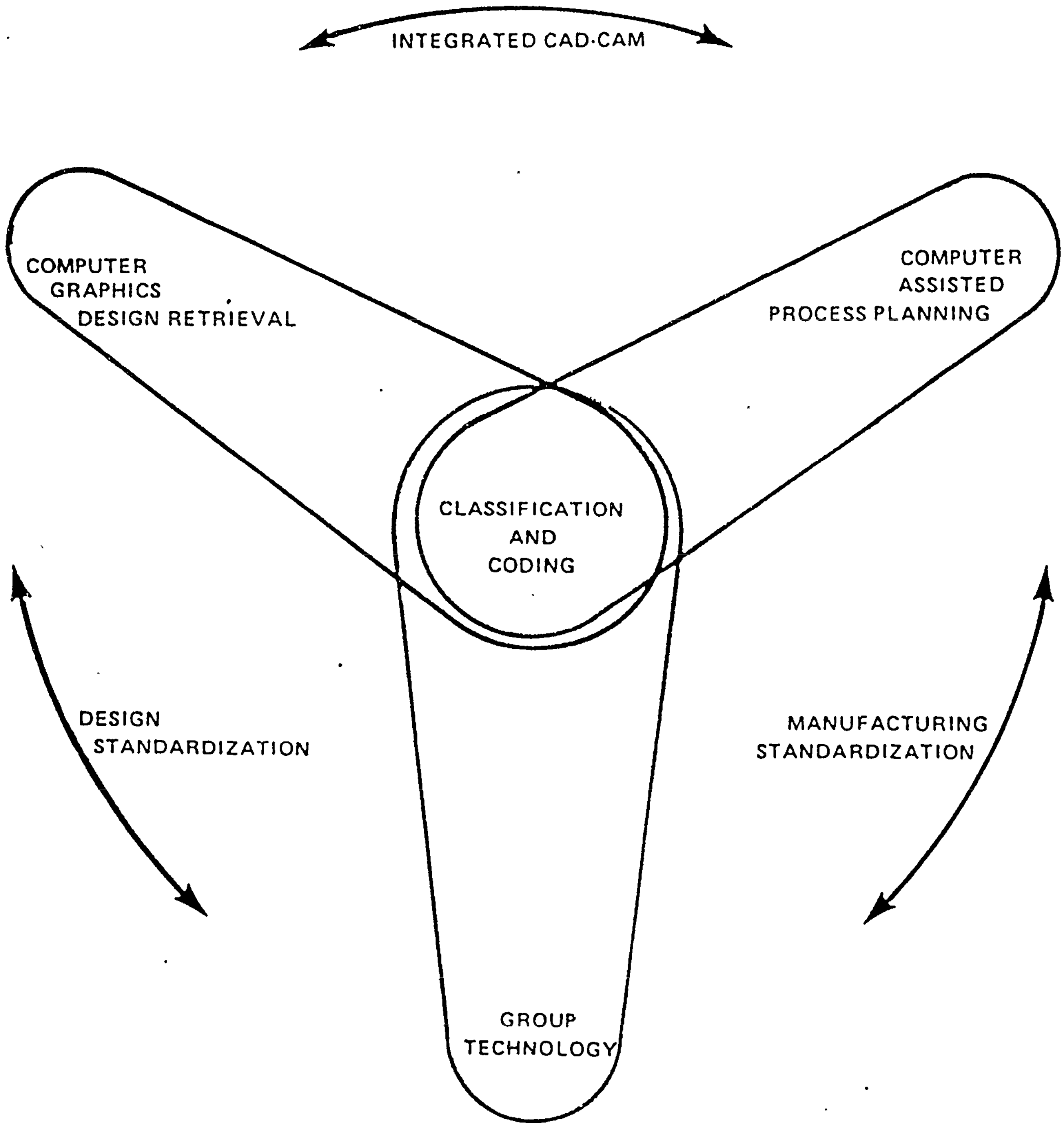
INTEGRATED CAD·CAM
COMPUTER GRAPHICS DESIGN RETRIEVAL
COMPUTER ASSISTED PROCESS PLANNING
CLASSIFICATION AND CODING
DESIGN STANDARDIZATION
MANUFACTURING STANDARDIZATION
GROUP TECHNOLOGY

FIGURE 1

will make it possible for them to use this information and integrate into their own tasks. All of the systems must talk in a common language and about the same kinds of things.

This is the philosophy behind the development of the MICLASS coding and classification system and its related systems, notably MIPLAN for computer assisted process planning, MIGRAPHICS for computer graphics, and MIGROUP for Group Technology.

Each of these systems can stand alone. All are integrated, however, so that they can utilize a common database and interrelate with each other.

For example, a computer graphics operator using the MIGRAPHICS system can begin by coding the part to be designed from a rough sketch. The resulting code number provides the designer with an access to the database. If the part, or a similar part has been designed in the past, the existing drawing can be retrieved on the designers graphics screen and, if necessary, modified. This obviously reduces the possibility of design proliferation. If Group Technology analysis has been used in the refinement of the database, than it is also likely that the design which appears on the screen will be one which can be produced most efficiently and at the lowest cost for the company.

Using the MIPLAN computer assisted process planning system, the process planner can also begin with a rough sketch and code the part. If the same part or similar parts have been produced in the past, that information will be immediately accessible through the code number. If Group Technology has been utilized, the process plan retrieved by the system will be the optimal one to produce the part - again reflecting the company's manufacturing capabilities and operating idiosyncrasies.

The information generated as each of these three systems are used increases the data available to everyone in the design and manufacturing areas. Because all of the systems are intergrated the pipeline is expanded in its diameter and more fluid - or in this case production'- can flow through the same operation in the same time.

It is this integration and cross-communication among systems which will make the promise of productivity through computerization a reality for batch manufacturing. In the years to come, new blades will be added to the propeller and the pipe will grow even wider.

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